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Original paper

Quality characteristics of biscuits supplemented with mango kernel and sugar beet molasses ingredients

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Abstract Mango kernel is largely treated as a waste material, but its flour can be used in many foods as a potential replace of wheat flour (WF). Sugar beet molasses (SBM) is a raw material with high possibility to be a functional ingredient in baked commodities. The aims of this research were to process mango kernel flour (MAKF) and sugar beet molasses (SBM) to comparison its chemical composition and minerals content and really to evaluate the quality of MAKF and SBM substituted composite biscuits by investigating chemical composition, minerals content, physical and textural characteristics and sensory evaluation of produced biscuits. The composition of MAKF and SBM showed higher concentration of ash (6.97 and 10.62%, respectively) compared to WF. MAKF showed higher amounts of fat and fiber than WF (3.22 and 2.34%, respectively). Moisture and ash contents of the developed biscuits increased with increasing of MAKF and SBM contents. MAKF increased all minerals content in the all prepared biscuits, while SBM caused an increase only in Na and Fe. Sensory evaluation indicated that 5% SBM and 10% MAKF containing biscuit were the most acceptable to the panelists among composite biscuits.

Keywords Mango kernel flour, Sugar beet molasses, Composite biscuit, Textural characteristics, Physical properties

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Introduction

Mango (*Mangifera indica* L.) is known as the type of fruits because of its delicious taste, attractive appearance and superior nutrients additionally huge production. Despite being a major part of mango, it is a matter to be regretful that the mango seeds are mostly thrown away as a waste material after consuming or processing of pulp while few amounts goes for plantation.

Several million tons of mango seeds and peels are omitted annually from food processing industries because thousand tons of mango fruits are manufactured in products such as puree, nectar, pickles and canned slices etc. which have worldwide popularity (Loelillet, 1994). By breaking the hard coat of mango seed, kernel is obtained. Mango seed kernel is nearly 20 per cent of total fruit weight.

This kernel is a great source of nutrients and natural bioactive compounds as well as has potentiality to use as anticancer, antibacterial and antioxidant compounds (Jahurul et al., 2015; Khammuang, & Sarnthima, 2011). Therefore, addition of MAKF in food products is regarded a good substitute for nutritional enhancement. Das, Sattar, Jony, & Islam (2018) found around 66.10-72.40% pulp, 8.40-12.4% kernel, 9.80-14.30% peel, and 7.50-9.30% seed coat. Also, Nzikou et al. (2010) illustrates that mango kernel contained about 42.50% moisture, 6.36% crude protein, 13.00% oils, 2.02% crude fiber, 3.20% ash and 32.24% total carbohydrate in dry weight basis whereas 50.98% moisture, 5.25% protein, 6.98% fat, 1.65% fiber and 2.47% ash in wet weight basis was reported by Elegbede, Achoba, & Richard (1995).

Beside the nutritional and bioactive attributes, mango kernel also possesses significant functional properties (Menon, Majumder, & Ravi, 2014). Demand of processed foods is increasing significantly throughout the world. Bakery products are also getting notable preference in the global food sector (Kotsianis, Giannou, & Tzia, 2002).

Biscuits are the most popularly consumed bakery items in the world. Some of the reasons for such wide popularity are their ready to eat nature, affordable cost, good nutritional quality, availability in different tastes and longer shelf-life (Bandyopadhyay, Chakraborty, & Bhattacharyya, 2014). Noticeable studies were executed by several researchers about utilization of MAKF in different bakery products. Bandyopadhyay et al. (2014) worked with MAKF and mango peel powder (MPP) to substitute wheat flour in cookies. They estimated that cookies can be produced by incorporating MAKF in WF up to 20% to get suitable color, flavor, texture and overall acceptability. Menon et al. (2014) revealed that bread can be formulated with enriched nutrient content by using mango seed kernel. Ajila, Aalami, & Leelavathi (2010) utilized mango peel powder as potential source of antioxidant in macaroni preparation. Molasses is the final syrup spun off after repeated crystallization in the extraction of sucrose (Douglas, & Glenn, 1982). SBM is abundant in antioxidants and has a clear industrial potential for preparation of extracts rich in antioxidants (Chen, Zhao, & Yu, 2015) and functional foods enriched with antioxidants (Chou, 2003). Molasses has a bitterly sweet taste. Extensive research has shown that it is possible to include beet molasses into formulations of various bakery, confectionery and meat products without negatively impacting their palatability and acceptance.

SBM can be used as a supplement in wheat-based bread and cookies: at 5-10% level flour basis in bread (Filipčev, Lević, Bodroža-Solarov, Mišljenović, & Koprivica, 2010) at 25% levels (flour basis) in semi-sweet cookies (Šimurina, Filipčev, Lević, Pribiš & Pajin, 2006) and as a replacer of half of the amount of honey in ginger nut biscuit formulations (Filipčev, Bodroža-Solarov, Šimurina, & Cvetković, 2012).

Against these backdrops, the main objective of this study is to characterize and analyze MAKF and SBM and to use them in biscuits preparation when substituted with WF in different proportions which may help for the treatment of iron deficiency.

Materials and Methods

Materials

Mango seeds, commercial soft WF (72% extraction), bakery fat, powdered sugar, skimmed milk powder, sodium chloride, sodium bicarbonate, ammonium bicarbonate and vanilla were purchased from the local market of Kafrelsheikh, Egypt. SBM was purchased from factory of sugar beet, Kafrelsheikh, Egypt.

Methods

Preparing of MAKF and SBM

Mango seeds were cleaned and washed twice with tap water, then left to dry in the air. After the stones were individually hammered to obtain the kernels of which the outer cover was removed by hand after kernels were soaked in sulphited tap water at 50 °C for 48 h followed by autoclaving for 30 min at 121 °C (for reduce tannins) and dried by tray drier at 23 °C According to (Legesse, & Admassu, 2012). The dried material was ground using a laboratory electronic mill into a powdery form (BRAWN, Model 2001 DL, Germany), (Lattanzio, Linsalata, Palmieri, & Van Sumere, 1989). After that dried MAKF were milled and kept in polyethylene bags at 4 °C until further analysis and processing. Molasses were separated from foreign matters.

Formulation of biscuit samples using different ratios of MAKF and SBM

The basic formulation of biscuit and composite of flour biscuit are outlined in Table (1)

Table 1. Formulation of different biscuit samples (1000 g flour basis):

Ingredients	A	B	C	D	E	F	G	H	H	I
WF (g)	1000	950	900	850	900	800	700	600	900	800
SBM (g)	0.00	50	100	150	0.00	0.00	0.00	0.00	50	100
MAKF (g)	0.00	0.00	0.00	0.00	100	200	300	400	50	100
Sugar (g)	195	195	195	195	195	195	195	195	195	195
Margarine (g)	50	50	50	50	50	50	50	50	50	50
Milk powder (g)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Ammonium bicarbonate (g)	15	15	15	15	15	15	15	15	15	15
Sodium metabisulphite (g)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Water (ml)	325	325	325	325	325	325	325	325	325	325
Salt (g)	3	3	3	3	3	3	3	3	3	3
Vanilla (ml)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Blend formulation and biscuit processing

Biscuit samples were prepared by replacing WF with different levels of composite flour in the basic formulation of biscuit (Table 1) as described in the methods of A.A.C.C. (2002). Blends of WF, MAKF and SBM for biscuit formulations were prepared and shown in Table (1).

Biscuit samples were processed from dough's containing 10, 20 and 30% MAKF and 5,10, 15% SBM as substituting levels for WF. Biscuit dough was formulated by blending WF, MAKF and SBM with other ingredients. The formulated blends were mingled for 15 min at 125 rpm (speed 2) using a mixer (type DITO - SAMA, Aubusson, France). Each boosts of the paste were removed from the mixer and allowed to rest for 10 min. The paste pieces were sheeted and flattened using roller into a sheet of about 8 mm thickness, and then cut into rectangular pieces with size, 4.5cm × 4.5 cm. Samples were baked in an electric oven (DiFioreForensic, Model, MLC80B, Fornimorello, Italy) at 249 ºC for 18 min.

After baking, biscuits were left to cool at room temperature and were wrapped tightly with polypropylene pouches and kept until further evaluation and analyses took place.

Gross chemical composition

Moisture, ash, protein, fiber and fat were determined according to A.O.A.C. (2000). Total carbohydrates were calculated by differences.

Texture profile analysis

Physical properties were recorded by texture profile analyzer. Texture measurements of samples were carried out with universal testing machine (Cometech, Btype, Taiwan) provided with software. 35 mm diameter compression disc was used. Two cycles were applied, at a constant cross head velocity of 1 mm/s, to 30-50% of sample depth, and then returned. From the resulting force-time, i.e. hardness (N) and adhesiveness (M.J) were calculated from the TPA graphic, according to Bourne (2003).

Sensory evaluation of biscuit samples

Sensory evaluation was carried out according to Lanza, Pagiarini, & Tamselli (1995). Biscuit samples were served to panel test of (10) judges to evaluate color, odour, taste, texture, appearance and overall acceptability using hedonic scale from (10) to (1). The scoring scheme was established as mentioned by Zobik, & Hoojjat (1984) as followed: Color (10), taste (10), odor (10), texture (10), appearance (10) and overall acceptability (10) degrees.

Physical measurements of biscuits

The spread factor, width and thickness of biscuits were evaluated according to A.A.C.C (2002), method no. 10-50D. The spread ratio was calculated by dividing width (W) by thickness (T).

Statistical analysis

One-way analysis of variance (ANOVA) was used to show the significant between biscuit samples. T-paired sample was used to study the significant between MAKF and SBM. The statistical software SPSS (Version 16.0, SPSS Inc., Chicago, IL) was used for analysis. All results were carried out in triplicate and data reported as mean ± standard deviation (SD).

Results and discussion

Chemical composition of MAKF and SBM

The prepared flours from MAKF and SBM were analyzed for chemical composition (Table 2) and compared to WF data reported by Bouazizi, Montevecchi, Antonelli, & Hamdi (2020). It could be noticed from Table (2) that the highest component in MAKF and SBM was carbohydrates (67.89 and 59.89%, respectively), while, the lowest component in both was fat which reached about 3.22 and 0.01%, respectively.

As shown in Table (2), MAKF had higher content of protein (8.78%) than SBM (6.76%), while molasses had higher content of ash (10.62%). Compared to the chemical composition of WF reported by Bouazizi et al. (2020), it was found that, MAKF had the lowest moisture content (10.80%) followed by WF (14.00%) and SBM (22.35%). SBM contained higher ash content (10.62%) than the MAKF (6.97%), while WF reported the lowest ash content reached about 0.53%.

Table 2. Gross chemical composition of MAKF, SBM and biscuit samples.

Sample	Moisture	Protein	Fat	Ash	Fiber	Total carbohydrates
MAKF	10.80±0.18	8.78±0.13*	3.22±0.09*	6.97±0.09	2.34*	67.89±0.55
SBM	22.35±0.19*	6.76±0.11	0.01±0.04	10.62±0.10*	0.10±0.15	59.89±0.47
A	8.22±0.12^{f}	9.63±0.14^{a}	4.65±0.09^{a}	1.11±0.08^{d}	0.43±0.09^{e}	75.96±0.64^{a}
B	9.62±0.20^{c}	8.23±0.11^{c}	3.81±0.21^{b}	1.61±0.07^{b}	0.45±0.13^{e}	76.28±0.34^{a}
C	10.33±0.18^{b}	8.01±0.16^{c}	3.52±0.11^{bc}	1.93±0.12^{a}	0.40±0.16^{e}	75.81±0.39^{a}
D	11.31±0.22^{a}	7.15±0.18^{d}	3.17±0.08^{c}	1.88±0.14^{ab}	0.44±0.20^{e}	76.05±0.54^{a}
E	8.55±0.17^{e}	9.29±0.17^{ab}	4.99±0.19^{ab}	1.27±0.11^{cd}	0.67±0.11^{c}	76.09±0.29^{a}
F	8.86±0.19^{d}	9.11±0.15^{ab}	5.19±0.17^{b}	1.36±0.10^{c}	0.81±0.26^{b}	75.98±0.24^{a}
G	9.22±0.09^{cd}	8.55±0.19^{bc}	5.33±0.10^{c}	1.43±0.11^{c}	0.93±0.08^{a}	76.43±0.45^{a}
H	9.44±0.20^{c}	8.77±0.20^{b}	4.76±0.12^{ab}	1.66±0.12^{b}	0.59±0.04^{d}	75.31±0.20^{a}
I	9.5±0.19^{c}	8.19±0.14^{c}	4.87±0.19^{bc}	1.82±0.09^{ab}	0.64±0.16^{d}	75.87±0.33^{a}

- The data were presented as mean ± S.D.
(*) Means in MAKF and SBM are significantly different at ($p \leq 0.05$).
- Means having the different case letter(s) within a column are significantly different at $P \leq 0.05$.
- A= control 100% WF; B= 95% WF + 5% SBM; C= 90% WF + 10% SBM; D = 85% WF + 15% SBM; E = 90% WF + 10% MAKF; F = 80% WF + 20% MAKF; G = 70% WF + 30% MAKF; H = 90% WF + 5% SBM + 5% MAKF and I = 80% WF + 10% SBM + 10% MAKF.

Protein content of MAKF and SBM was lower than that of WF (8.78 and 6.76% vs. 12.60%), but MAKF had remarkably higher fat content (3.22%) compared to WF and SBM (1.16 and 0.01%, respectively). WF gave higher carbohydrate content (71.20%) than MAKF and SBM (67.89 and 59.89%, respectively). The high ash content of SBM and MAKF indicates that they can be good sources of minerals. Bandyopadhyay et al. (2014), Yatnatti, Vijayalakshmi, & Chandru (2014) and Das, Khan, Rahman, Majumder, & Islam (2019) reported similar carbohydrate (69.77, 73.10 and 72.02%, respectively) and protein (7.53, 7.53 and 8.03%) contents in MAKF. Higher fat content was obtained by Bandyopadhyay et al. (2014) and Joyce, Latayo, & Onyinye (2014) which reached about 9%. On the other hand, lower fat content was reported by Das et al. (2018) (0.64%). On the contrary, ash amount stated by Das et al. (2018) and Bandyopadhyay et al. (2014) was lower than out result. Different mango varieties and determination process may be the facts for deviation of the results. According to Odunsi (2005), mango seed kernel flour can be used in the manufacturing of cakes, cookies and breads for adults and children. Šarić et al. (2016) reported near results for protein and ash contents in SBM. Lower amount for ash content were mentioned by Lončar et al. (2020) and Pătraşcu, Râpeanu, Bonciu, Vicol, & Bahrim (2009).

Mineral content of SBM and MAKF

Data in Table (3) presented the minerals content (mg/100g) in MAKF and SBM. All minerals content in MAKF were significantly higher than in SBM. The predominate mineral in MAKF was K followed by Mg which reached about 83.60 and 74.66 mg/100g, respectively.

In molasses, K, Na and Fe were reported to be about 6 mg/100g. Ca in MAKF and SBM reached about 27.90 and 1.32 mg/100g. MAKF showed a small amount of Fe reached about 9.93 mg/100g. Close results were obtained by Abdelaziz (2018) and Yatnatti et al. (2014) for Fe in mango kernel (9.3 and 12 mg/100g, respectively). Also, for Ca Elgindy (2017) and Nzikou et al. (2010) reported near contents to our findings. While K and Mg were lower than the results demonstrated by Yatnatti et al. (2014), Abdelaziz (2018), Elgindy (2017), Gumte, Taur, Sawate, & Kshirsagar (2018). On the other side, Na showed higher content than the other reported by Abdelaziz (2018), Nzikou et al. (2010) and Yatantti et al. (2014) and in harmony with Gumte et al. (2018). For SBM, higher amounts of K, Ca, Mg and Na were reported by Lončar et al. (2020) and Lević, Razmovski, Vučurović, Koprivica, & Mišljenović (2008), while Fe amount which reported by Lončar et al. (2020) was near to our findings (5.32 mg/100g). Generally, variation in mineral contents between samples could be due to cultivation climate, ripening stage, variety of plant, harvesting time of seeds and extraction method used.

Chemical composition of biscuit samples

Biscuits were selected as a food matrix due to their global diffusion, long shelf-life and the possibility of being easily exported. Chemical composition of biscuit samples with MAKF and SBM was presented in Table (2). Adding MAKF and SBM in different levels to biscuits caused a significant increase in moisture amount as did ash content in comparison with control sample.

These results are supported by Ashoush, & Gadallah (2011) and Bolek (2020) who enriched biscuits with mango peels and olive stone powder. As the proportion of MAKF and SBM in the biscuit formulation increased, the protein content of biscuit samples decreased significantly. This was expected for the lower protein content in MAKF and SBM than in WF.

On the other side, the higher the amount of MAKF in the biscuit formulation, the higher the fat content in biscuit samples. This result may be due to the high fat content of MAKF (Bandyopadhyay et al., 2014; Joyce et al., 2014). Different results were obtained in SBM for fat content in biscuits, which decreased as increasing of SBM percentage.

This result could be attributed to fat content of SBM which was lower than WF. Non-significant differences were mentioned between biscuit samples in total carbohydrates. Biscuit samples with 5 and 10% of SMB and MAKF, respectively, showed higher moisture and ash contents and lower protein and fat amounts in comparison with control sample. Fiber content did not change significantly as a result of using SBM in biscuit production.

On the other side, MAKF showed significant effect on fiber content of biscuits. Increasing the amount of MAKF caused an increase in fiber content reached the highest level by using 30% MAKF (0.93%).

Table 3. Minerals content of MAKF, SBM and biscuit samples.

Sample	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Iron (Fe)
MAKF	83.60	27.90	74.66	20.36	9.93
SBM	6.64	1.32	3.17	6.24	6.99
A	65.32	25.17	40.73	51.68	2.02
B	60.18	18.77	32.50	52.43	3.13
C	53.27	13.03	25.82	53.12	3.88
D	49.91	10.67	20.19	53.87	4.01
E	76.16	26.52	51.11	64.23	4.21
F	81.01	27.16	62.32	78.40	4.56
G	90.79	27.93	73.54	89.04	4.96
H	67.34	24.71	42.81	65.57	4.08
I	68.12	25.33	46.14	77.05	4.28

- The data were presented as mean ± S.D.
- Means having the different case letter(s) within a column are significantly different at $P \leq 0.05$.
- A= control 100% WF; B= 95% WF + 5% SBM; C= 90% WF + 10% SBM; D = 85% WF + 15% SBM; E = 90% WF + 10% MAKF; F = 80% WF + 20% MAKF; G = 70% WF + 30% MAKF; H = 90% WF + 5% SBM + 5% MAKF and I = 80% WF + 10% SBM + 10% MAKF.

Minerals content of biscuit samples

The biscuit samples were estimated for minerals content and the results were shown in Table (3). In comparison to the control, Table (3) showed that, higher molasses content contributed to lower K (60.18 to 49.91 mg/100g), Ca (18.77 to 10.67 mg/100g) and Mg (32.50 to 20.19 mg/100g) contents and higher Na (52.43 to 53.78 mg/100g) and Fe (3.13 to 4.01 mg/100g) in the biscuits in comparison to the corresponding controls (65.32, 25.17, 40.73, 51.68 and 2.02 mg/100 for K, Ca, Mg, Na and Fe, respectively).

The reason for this is the low amount of K, Ca and Mg in SBM, while WF had more amounts of these minerals. Also, the increase in Fe amount in SBM than in WF led to an increase in Fe content in biscuit samples. MAKF is a perfect source of minerals. Its addition is expected to increase the content of minerals and the elevated mineral content in formulations with molasses confirms this.

Increasing the amount of MAKF replaced with WF caused a raise in mineral contents in biscuit samples. The highest mineral amount was recorded in 30% MAKF. K, Mg and Na recorded higher increase in biscuit samples than Ca and Fe as a result of adding MAKF. These results were in harmony with Salem (2020) who reported an increase in mineral contents in biscuit produced by different percentages of mango seed kernel. Filipčev, Mišan, Šarić, & Šimurina (2016) indicated that increasing molasses doses resulted in remarkable increases in the observed macro and microelements. This note was similar to Fe and Na content in our biscuit samples, but not with other minerals content. The minerals Mg, Ca and K are important for the effectiveness of insulin and their deficiency in the diet has been associated with increased risk of developing diabetes (Wright, Ellis, & Ilag, 2014).

Physical properties of biscuit samples

Data in Table (4) showed the width, thickness and spread ratio of biscuit samples. Among the attributes the physical properties of biscuit depends on the composition of matrix. For width, control sample showed the highest value (46.51 mm). The spread ratio, width and thickness values of control and biscuit samples were ranged from 8.38 to 11.01, 40.32 to 46.51 and 3.81 to 4.95 respectively The width of biscuits significantly decreased as adding MAKF and SBM corresponding to control sample.

This decrease may be due to the reduction of the gluten structure with increased levels of WF replacement (Choudhury, Badwaik, Borah, Sit, & Deka, 2015). 5% and 10% of SBM followed the control sample in width value (42.75 and 42.31 mm, respectively). The samples produced by blinding SBM and MAKF at 5 and 10% no significant differences were noticed between each other and 5 and 10% SBM.

Increasing the amount of SBM caused a decrease in biscuits width. While increasing the amount of MAKF caused an increase in the width of biscuits which reached

41.20 and 41.93 mm in 20 and 30% of MAKF without significant differences. The thickness of the biscuit samples significantly decreased with increasing fat content which is in line with the findings of Pareyt et al. (2009).

So, adding SBM by 5, 10 and 15% and MAKF by 20 and 30% showed a decrease in the thickness of biscuit samples. Using SBM by 10 and 15% and MAKF by 20 and 30% reported no significant differences in biscuits thickness. This was in agreement with Filipčev, Šimurina, & Bodroža-Solarov (2014) who mentioned that increasing the molasses content did not significantly affect thickness in any of the tested biscuit variants.

Increasing the percentage of replacement of WF with SBM caused an increase in spread ratio. SBM different percentages showed higher spread ratio than control reached the highest value by adding 15% SBM (11.01). This may be due to the addition of liquid molasses yielded softer gluten-free cookies with higher spread and better pronounced color properties (Filipčev et al., 2016). On the other side, 20 and 30% MAKF represented non-significant results with control. This was the same effect during using 10% SBM and 10% MAKF. Only using 10% MAKF and 5% SBM and 5% MAKF showed lower value of spread ratio than control sample (8.38 and 8.62, respectively).

Table 4. Physical properties and textural characteristics of biscuit samples.

Sample	Width	Thickness	Spread ratio	Hardness (N)	Adhesiveness
A	46.51±0.28^{a}	4.95±0.11^{a}	9.40±0.20^{c}	17.01±0.16^{a}	0.22±0.05^{a}
B	42.75±0.32^{b}	4.21±0.09^{b}	10.15±0.09^{b}	10.91±0.11^{e}	0.13±0.03^{b}
C	42.31±0.24^{b}	3.91±0.17^{c}	10.82±0.18^{ab}	10.75±0.19^{e}	0.14±0.06^{b}
D	41.98±0.18^{c}	3.81±0.10^{c}	11.01±0.15^{a}	10.42±0.22^{e}	0.11±0.08^{b}
E	40.32±0.31^{d}	4.81±0.19^{a}	8.38±0.12^{d}	12.52±0.11^{d}	0.01±0.009^{c}
F	41.20±0.12^{c}	4.42±0.12^{b}	9.32±0.17^{c}	10.27±0.13^{e}	0.02±0.05^{c}
G	41.93±0.22^{c}	4.41±0.16^{b}	9.50±0.16^{c}	9.55±0.18^{f}	0.04±0.004^{c}
H	42.51±0.20^{b}	4.93±0.20^{a}	8.62±0.20^{d}	16.21±0.22^{b}	0.22±0.20^{a}
I	41.45±0.11^{b}	4.42±0.10^{b}	9.37±0.20^{c}	15.47±0.16^{c}	0.20±0.04^{a}

- The data were presented as mean ± S.D.
- Means having the different case letter(s) within a column are significantly different at $P \leq 0.05$.
- A= control 100% WF; B= 95% WF + 5% SBM; C= 90% WF + 10% SBM; D = 85% WF + 15% SBM; E = 90% WF + 10% MAKF; F = 80% WF + 20% MAKF; G = 70% WF + 30% MAKF; H = 90% WF + 5% SBM + 5% MAKF and I = 80% WF + 10% SBM + 10% MAKF.

Textural characteristics of biscuit samples

The mechanical characteristics of biscuits are important to evaluate the acceptance point of view of consumer. The effects of MAKF and SBM on textural characteristics of biscuit dough were given in Table (4). Significant differences were reported between control and SBM and MKF samples. The use of different ratios of SBM to the biscuit formulation did not significantly affected hardness. Filipčev et al. (2016) stated that dry molasses increased hardness whereas liquid molasses decreased it. Using MAKF at different ratios caused significant differences in hardness. Using 10% from MAKF recorded the highest hardness result (12.52) among the other used ratios, while increasing the amount of MAKF in biscuit formulation caused low in hardness reached about 10.27 and 9.55 for 20% and 30% MAKF, respectively.

This behavior was related to the high fibre content (which was low in SBM and MAKF), and therefore to hydroxyl groups, which establish strong interactions with gluten proteins via water interactions through hydrogen bonds (Rosell, Rojas, & De Barber, 2001). Our results were in opposite with the others observed by Aslam et al. (2014) who stated that the biscuits with 15% mango kernel powder and 95% flour and with 15% was significantly harder than biscuits that made with 100% flour. Also, the hardness of the biscuit dough formulated with prickly pear peel flour significantly increased with increasing the amount of prickly pear peel flour (Bouazizi et al., 2020).

Similar results were obtained by Bolek (2020) who reported that hardness of biscuit dough increased significantly as the proportion of olive stone powder increased. Using MAKF and SBM caused a decrease in adhesiveness of biscuit samples in comparison with control. Non-significant differences were reported during increasing MAKF and SBM percentage in biscuit samples. Adhesiveness was higher in SBM than MAKF biscuit samples.

Dough adhesiveness was significantly affected by the fat content; higher fat content (MAKF had higher fat content than SBM) decreased dough adhesiveness (Filipčev et al., 2014). This was similar to Filipčev et al. (2014) who illustrated that no significant variations were reported in molasses biscuit types. Adding SBM and MAKF together with 5 and 10% to the biscuit formulation caused near result in hardness and adhesiveness in comparison with control sample.

Sensory evaluation of biscuit samples

Table (5) reveals the sensory attributes of biscuit from various blends of WF and MAKF and SBM. Control biscuit showed maximum color mean score of 9.7, which was the highest, obtained among the type of biscuit followed by 5 and 10% SBM which reported mean score 9.2 and 8.2, respectively.

In addition, sample 30% MAKF secured the lowest score (6.6) while sample 10% SBM and MAKF secured second lowest score (6.6) but both were equally acceptable. The decrease in color in MAKF samples is due to the fact that as blending ratio with MAKF increases, this in turn affects and led to the color change of the biscuits to darkness (Legesse, & Emire, 2012).

This change in color while increasing the blending ratio of MAKF might be due to the nutrients interaction during processing and baking time with temperature combination (Legesse, & Emire, 2012). For flavor, ANOVA test revealed that there was significant difference among the biscuit samples at 5% level of significance. Among the MAKF supplanted biscuits, the sample 10% secured the highest score of 7.2 while sample 30% reported the lowest score of 6.5 among all samples.

Table 5. Sensory evaluation of biscuit samples.

Sample	Color	Taste	Adour	Texture	Appearance	Overall acceptability
A	9.7±0.12[a]	9.3±0.14[a]	9.1±0.16[a]	9.2±0.11[a]	9.4±0.12[a]	9.4±0.10[a]
B	9.2±0.15[b]	8.7±0.11[b]	9.1±0.09[a]	9.0±0.09[a]	9.2±0.09[a]	9.1±0.18[a]
C	8.2±0.13[c]	8.1±0.08[c]	8.4±0.21[b]	8.6±0.13[b]	8.2±0.16[b]	8.3±0.21[b]
D	7.7±0.11[d]	7.5±0.16[d]	7.8±0.13[c]	7.7±0.16[c]	7.9±0.20[c]	7.7±0.15[c]
E	6.8±0.11[e]	7.2±0.13[de]	7.2±0.10[d]	7.5±0.18[cd]	7.2±0.19[d]	7.4±0.24[cd]
F	6.9±0.09[e]	6.8±0.10[e]	6.8±0.14[de]	7.0±0.10[d]	7.0±0.20[d]	7.0±0.24[d]
G	6.6±0.10[f]	6.3±0.09[f]	6.2±0.17[e]	6.4±0.19[e]	6.5±0.18[f]	6.5±0.11[e]
H	7.2±0.13[d]	7.1±0.14[de]	7.0±0.15[d]	6.9±0.12[d]	7.1±0.15[d]	7.0±0.24[d]
I	6.6±0.14[f]	6.8±0.20[e]	6.9±0.15[de]	6.5±0.20[e]	6.8±0.12[e]	6.7±0.14[e]

- The data were presented as mean ± S.D.
- Means having the different case letter(s) within a column are significantly different at $P \leq 0.05$.
- A= control 100% WF; B= 95% WF + 5% SBM; C= 90% WF + 10% SBM; D = 85% WF + 15% SBM;E = 90% WF + 10% MAKF; F = 80% WF + 20% MAKF; G = 70% WF + 30% MAKF; H = 90% WF + 5% SBM + 5% MAKF and I = 80% WF + 10% SBM + 10% MAKF.

For SBM, the sample 5% SBM showed the highest score of taste (8.7) after control sample and as the percentage of SBM increased in samples, the taste score decreased. In case of adour, texture and appearance it was seen that the sample containing 100% WF secured the highest scores (9.1, 9.2 and 9.4, respectively) and was equally acceptable as sample having 90% WF and 10% SBM securing scores of 9.1, 9.0 and 9,2, respectively, while the sample containing 10% MAKF reported higher adour, texture and appearance scores (7.2, 7.5 and 7.2, respectively) than 20 and 30% of MAKF. The biscuits made by adding 5% MAKF + 5% SBM were better than the others produced by adding 10% MAKF + 10% SBM. From the previous results it could be noticed that biscuits produced by adding SBM were more acceptable than the samples with MAKF.

Blending of MAKF with WF significantly decreased the color, taste, odor, texture, appearance and overall acceptability of biscuit as the proportion of MAKF blend ratio increased. These findings were close to the results reported by Legesse, & Emire (2012) and Ifesan (2017). Finally, sample having 100% WF, 95% WF and 5% SBM were not varied significantly based on overall acceptability but rest samples differed significantly from former two.

Therefore, based on the sensory evaluation of the developed biscuits, it could be said that supplementation of SBM and MAKF with WF would result in lowering the consumer preference but up to 15% SBM and 30% MAKF supplementation had not affect much.

Conclusion

The physicochemical and phytochemical analyses carried out on MAKF and SBM revealed that they could be good source of balanced food material which could be utilized in food production especially confectionary industry. The utilization of MAKF with WE to produce biscuit resulted to a biscuit with improved ash content. Utilization of MAKF and SBM for commercial purposes can reduce the environmental pollution which resulted as by-product from mango and sugar beet processing industries and contribute to food security by converting waste to valuable food products. From the present study it could be concluded that blends containing up to 5 and 10% SBM was suitable for the development of biscuits.

Beyond 30% blends of MAKF, the color of the biscuits become darken attributable to the Maillard browning reaction, presence of high fiber composition and baking process parameters. Addition of MAKF significantly improved the micronutrient pattern in the biscuits by raising the levels of macro- and micro-minerals. While using SBM improved the level of Na and Fe in produced biscuits. The partial substitution of WF with MAKF and SBMF to produce biscuits is a promising strategy in the manufacturing of bakery products.

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Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. A.A.C.C. (2002). Approval Methods of American Association of Cereal Chemists, in St. Paul, Minnesota, USA.

2. A.O.A.C. (2000). Association Official Analytical Chemists.Official Methods of Analysis.7th ed., Washington DC, USA.
3. Abdelaziz, S. A. (2018). Physico chemical characteristics of mango kernel oil and meal. *Middle East Journal of Applied Sciences, 8*(1), 1-6.
4. Ajila, C. M., Aalami, M., Leelavathi, K., PrasadaRao, U. J. S. (2010). Mango peel powder: A potential source of antioxidant and dietary fiber in macaroni preparations. *Innovative Food Science & Emerging Technologies, 11*, 219-224.
5. Ashoush, I. S., Gadallah, M. G. E. (2011). Utilization of mango peels and seed kernels powders as sources of phytochemicals in biscuit. *World Journal of Dairy & Food Sciences, 6*(1), 35–42.
6. Aslam, H. K., Raheem, M. L., Ramzan, R., Shakeel, A., Shoaib, M., Sakandar, H. A. (2014). Utilization of mango waste material (peel, kernel) to enhance dietary fiber content and antioxidant properties of biscuit. *Journal of Global Innovations in Agricultural and Social Sciences, 2*(2), 76-81.
7. Bandyopadhyay, K., Chakraborty, C., Bhattacharyya, S. (2014). Fortification of mango peel and kernel powder in cookies formulation. *Journal of Academia and Industrial Research, 2*(12), 661–664.
8. Bolek, S. (2020). Olive stone powder: A potential source of fiber and antioxidant and its effect on the rheological characteristics of biscuit dough and quality. *Innovative Food Science & Emerging Technology. 64*, 102423.
9. Bouazizi, S., Montevecchi, G., Antonelli, A., Hamdi, M. (2020). Effects of prickly pear (*Opuntia ficus-indica* L.) peel flour as an innovative ingredient in biscuits formulation. *LWT, 124*, 109155.
10. Bourne, M. C. (2003). Food texture and viscosity: Concept and measurement. Elsevier Press, New York/London.
11. Chen, M., Zhao, Y., Yu, S. (2015). Optimisation of ultrasonicassisted extraction of phenolic compounds, antioxidants, and anthocyanins from sugar beet molasses. *Food Chemistry, 172*, 543–550.
12. Chou, C. C. (2003). Preparation antioxidants enriched functional food products from sugar cane and beet. United States Patent Applications127141.
13. Choudhury, M., Badwaik, L. S., Borah, P. K., Sit, N., Deka, S. C. (2015). Influence of bamboo shoot powder fortification on physico-chemical, textural and organoleptic characteristics of biscuits. *Journal of food science and technology, 52*(10), 6742–6748.
14. Das, P. C., Khan, M. J., Rahman, M. S., Majumder, S., Islam, M. N. (2019). Comparison of the physico-chemical and functional properties of mango kernel flour with wheat flour and development of mango kernel flour based composite cakes. *NFS Journal, 1*(17),1-7.
15. Das, P. C., Sattar, S., Jony, M. E., Islam, M. N. (2018). Rehydration kinetics of flour from dehydrated mango kernel. *Food Research, 2*(5), 474–480.
16. Douglas, M. C., Glenn, D. C. (1982). Foods and food production encyclopedia. Van nostrandReinhold . P1941
17. Elegbede, J., Achoba, I., Richard, H. (1995). Nutrient composition of mango (*Mangnifera indica*) seed kernel from Nigeria. *Journal of food biochemistry, 19*(5), 391–398.
18. Elgindy, A. A. (2017). Chemical and technological studies of mango seed kernel. *European Journal of Food Science and Technology, 5*(2), 32-40.
19. Filipčev, B., Bodroža-Solarov, M., Šimurina, O., Cvetković, B. (2012). Use of sugar beet molasses in processing of gingerbread type biscuits: effect on quality characteristics, nutritional profile, and bioavailability of calcium and iron. *Acta alimentaria. 41*(4), 494-505.
20. Filipčev, B., Lević, L., Bodroža-Solarov, M., Mišljenović, N., Koprivica, G. (2010). Quality characteristics and antioxidant properties of breads supplemented with sugar beet molasses-based ingredients. *International Journal of Food Properties, 13*(5), 1035-53.
21. Filipčev, B., Mišan, A., Šarić, B., Šimurina, O. (2016). Sugar beet molasses as an ingredient to enhance the nutritional and functional properties of gluten-free cookies. *International Journal of Food Sciences and Nutrition, 67*(3), 249-256.
22. Filipčev, B., Šimurina, O., Bodroža-Solarov, M. (2014). Quality of gingernut type biscuits as affected by varying fat content and partial replacement of honey with molasses. *Journal of food science and technology, 51*(11), 3163-71.
23. Gumte, S. V., Taur, A. T., Sawate, A. R., Kshirsagar, R. B. (2018). Effect of fortification of mango (*Mangifera indica*) kernel flour on nutritional, phytochemical and textural properties of biscuits. *Journal of Pharmacognosy and Phytochemistry, 7*(3), 1630-1637.
24. Ifesan, B. O. (2017). Chemical properties of mango kernel and seed and production of biscuit from wheat-mango kernel flour blends. *International Journal of Food and Nutrition Research, 1*, 5.
25. Jahurul, M. H. A., Norulaini, N. A. N., Zaidul, I. S. M., Jinap, S., Sahena, F., Azmir, J., Sharif, K. M. Omar, A. M. (2015). Mango (*Mangifera indica* L.) by-products and their valuable components: a review. *Food Chemistry, 183*, 173–180.
26. Joyce, O. O., Latayo, B. M., Onyinye, A. C. (2014). Chemical composition and phytochemical properties of mango (*Mangifera indica*.) seed kernel. *International Journal of Advanced Chemistry, 2*,185-7.
27. Khammuang, S., Sarnthima, R. (2011). Antioxidant and antibacterial activities of selected varieties of Thai mango seed extract. *Pakistan journal of pharmaceutical sciences, 24*(1), 37–42.
28. Kotsianis, I. S., Giannou, V., Tzia, C. (2002). Production and packaging of bakery products using MAP technology. *Trends in Food Science & Technology, 13*, 319–324.

29. Lanza, C. M., Pagiarini, E., Tamselli, F. (1995). Sensory and chemical evaluation of frozen blood orange juice. *Agricoltura Mediterranea, 125*, 421-426.
30. Lattanzio, V., Linsalata, V., Palmieri, S., Van Sumere, C. F. (1989). The beneficial efficial effect of citric acid and ascorbic acid on the phenolic browning reaction in stored artichoke (*Cynara scolymus*, L.) heads. *Food Chemistry, 33*, 93-106.
31. Legesse, M. B., Admassu, S. (2012). Functional and physicochemical properties of mango seed kernels and wheat flour and their blends for biscuit production. *African Journal of Food Science and Technology, 3*(9), 193-203.
32. Legesse, M. B., Emire, S. A. (2012). Functional and physicochemical properties of mango seed kernels and wheat flour and their blends for biscuit production. *African Journal of Food Science and Technology, 3*(9), 193-203.
33. Lević, L., Razmovski, R., Vučurović, V., Koprivica, G., Mišljenović, N. (2008). Appliance of sugar beet molasses after osmotic dehydration of apple for bioethanol production. *Časopis za procesnu tehniku i energetiku u poljoprivredi/PTEP. 12*(4), 219-221.
34. Loelillet, D. (1994). The European mango market: A promising tropical fruit. *Fruit, 49*, 5-9.
35. Lončar, B., Nićetin, M., Filipović, V., Knežević, V., Pezo, L., Šuput, D., Kuljanin, T. (2020). Osmotic dehydration in sugar beet molasses-food safety and quality benefits. *Journal of Hygienic Engineering and Design,* 15-20.
36. Menon, L., Majumder, S. D., Ravi, I. (2014). Mango (*Mangifer aindica* L.) kernel flour as a potential ingredient in the development of composite flour bread. *Indian Journal of Natural Products and Resources, 5*(1), 75–82.
37. Nzikou, J. M., Kimbonguila, A., Matos, L., Loumouamou, B., Pambou-Tobi, N. P. G., Ndangui, C. B., Abena, A. A., Silou, Th., Scher, J., Desobry, S. (2010). Extraction and characteristics of seed kernel oil from mango (*Mangifera indica*). *Research Journal of Environmental and Earth Sciences, 2*(1), 31–35.
38. Odunsi, A. (2005). Response of laying hens and growing broilers to the dietary inclusion of mango (*Mangifera indica* L.) seed kernel meal. *Tropical Animal Health and Production, 37*(2), 139-150.
39. Pareyt, B., Talhaoui, F., Kerckhofs, G., Brijs, K., Goesaert, H., Wevers, M., Delcour, J. (2009). The role of sugar and fat in sugar-snap cookies: structural and textural properties. *Journal of Food Engineering, 90*, 400–408.
40. Pătraşcu, E., Râpeanu, G., Bonciu, C., Vicol, C., Bahrim, G. (2009). Investigation of yeast performances in the fermentation of beet and cane molasses to ethanol production. *Ovidius University Annals of Chemistry, 20*(2), 199-204.
41. Rosell, C. M., Rojas, J. A., De Barber, C. B. (2001). Influence of hydrocolloids on dough rheology and bread quality. *Food Hydrocolloids, 15*, 75–81.
42. Salem, B. R. (2020). Use of tomato pomace, mango seeds kernel and pomegranate peels powders for the production of functional biscuits. *Zagazig Journal of Agricultural Research, 47*(4), 1011-1023.
43. Šarić, L. C., Filipčev, B. V., Šimurina, O. D., Plavšić, D. V., Šarić, B. M., Lazarević, J. M., Milovanović, I. L. (2016). Sugar beet molasses: properties and applications in osmotic dehydration of fruits and vegetables. *Food and Feed Research, 43*(2), 135-44.
44. Šimurina, O., Filipčev, B., Lević, L., Pribiš, V., Pajin, B. (2006). Sugar beet molasses as an ingredient in tea-cookie formulation. *Journal on Processing and Energy in Agriculture, 10*(3-4), 93-6.
45. Wright, A. G., Ellis, T. P., Ilag, L. L. (2014). Filtered molasses concentrate from sugar cane: natural functional ingredient effective in lowering the glycaemic index and insulin response of high carbohydrate foods. *Plant foods for human nutrition, 69*, 310–316.
46. Yatnatti, S., Vijayalakshmi, D., Chandru, R. (2014). Processing and nutritive value of mango seed kernel flour. *Current Research in Nutrition and Food Science Journal, 2*(3), 170-5.
47. Zobik, M. E., Hoojjat, P. (1984). Sugar-snap cookies with wheat-navy bean sesame seed flour blend. *Cereal Chemistry, 61*, 41-44.